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(54) Title: METHOD AND APPARATUS FOR THE MANUFACTURE OF MEAT

(57) Abstract

A method of manufacturing a texturised proteinaceous meat analogue product, including: subjecting, in a food extruder, a mixture containing: about 40 to 95 % by weight edible proteinaceous materials selected from the group consisting of predetermined mixtures of defatted soy flour, soy meal, soy concentrate, cereal gluten in vital or starch–containing form and egg white, and up to about 7 % by weight of edible mineral binding and cross–linking compounds; to mechanical pressure and added heat sufficient to convert the mixture into a hot, viscous protein lava; extruding the protein lava through and from a temperature controlled cooling die which cools and reduces the viscosity of the protein lava to obtain a cohesive, texturised, extrudate slab or ribbon in which vapour–flashing is substantially inhibited; and subjecting the solidified extrudate slab or ribbon to mechanical shredding in a hammer mill having a cage plate with a plurality of elongate discharge openings and a plurality of hammer bars hinged to discs attached to a rotating shaft, so as to obtain a plurality of extrudate shreds that resemble in consistency and texture flaked or shredded meat.

subsequent cooling process, stable mineral compounds which do not leach out from the extrudate and stay in matrix with the protein and fibre components during subsequent process treatment, (e.g. in food pasteurisation and canning procedures) as well as nutritional mineral supplements.

Some of the ingredients listed in Table 2 may be substituted with other ingredients having similar properties. For example, Table 3 lists substituents that have been successfully tested in the manufacture of a shredded TPP that satisfies the above mentioned criteria and desired characteristics in relation to mimicking tuna fish flakes.

Table 3

Ingredient	Substituent
Defatted soy flour	soy meal
Defatted soy flour	soy concentrate
Vital wheat gluten	egg white powder
Vital wheat gluten	Vital wheat gluten / maize gluten
Vital wheat gluten	Vital wheat gluten / wheat flour

The substituents listed above are generally preferred, although the object of the invention may still be achieved by using other functional, high protein sources (eg. cereal or meat fractions).

Example 1

A manufacturing process, using production line 10, for a desired meat analogue product using ingredients listed in Table 2 will now be described.

The ingredients are pre-blended in a weight range as indicated in Table 2 in ribbon blender 18 and metered into extruder 22 using mass dry material hopper 20. The moisture content of the dry ingredient blend is typically in the range 9 - 14% by weight. Water is metered into the first or second section of the extruder barrel through injection port 26. Steam may also be used, metered into the extruder's second or third barrel section.

The extruder screw(s) convey the moistened mixture toward the outlet at the last extruder barrel 22e, the mixture being hereby subjected to increasing shear and pressure. Temperature in the barrel sections is generally set between 60 – 140°C, the higher temperatures being present at the middle barrel sections where plastification and "melting" of the dry

precursor materials is mostly effected, whereas pressure within the extruder barrels attains levels generally between 3 - 8 MPa, depending on whether a barrel section contains paddles or screw flights intended primarily to convey the mixture towards the extruder outlet or mainly impart shear to the plastifying mixture and therefore increase back pressure. The screw speed is normally set at between 200 - 350 rpm.

The hot, viscous proteinaceous lava created from the dry materials and water is pressed through the holes of breaker plate 33 (also called a primary die plate) which is situated downstream of the last conveying flight or paddle of the extruder screws.

After flowing through primary die plate 33, the hot extrudate mass flows through transition piece 35 into cooling die 34. The primary function of the cooling die is to prevent the extrudate being subject to vapour flashing and uncontrolled expansion (puffing) by physically constraining the extrudate in the die and cooling the extrudate to decrease water vapour pressure to about ambient conditions. The cooling die promotes formation of a dense, fibrous texture that is an important attribute of the product. For further details on the precise mechanics of texturisation of proteinaceous materials, reference should be had to the literature mentioned in the introductory part of the description.

Upon leaving cooling die 34, the continuous, slab or band-like extrudate product is sufficiently cool that it does not expand significantly and therefore has a relatively dense, fibrous texture. Typically, the product has at that stage a moisture content of about 40 - 60% by weight and is relatively tough-elastic. Product density will normally be between 0.85 and 1.05 kg/l.

The extruded product is conveyed by transport conveyor 42 from the cooling die outlet directly to cutting / shredding device 48, whilst being subjected to water mist spraying to enhance surface solidification of the product prior to the shredding operation, without further substantial cooling of the extrudate.

The continuous band of extrudate product enters hammer mill 48 through chute 50 at the top of the unit and is broken up by the spinning hammers 59 and made to pass through the slit-like or oblong openings of

screen 53 located below said hammers. Shredded TPP is discharged through chute 52 onto conveyor 62 or any other suitable vessel.

After shredding, the product is ready for further use or processing. It may be used immediately, or frozen for use at a later stage. When used as a meat extender in pet food products, the shredded product would be mixed with fish, chicken or other meats as well as vitamins, minerals, gelling agents and gravy before being filled into cans, trays or other containers, and then subjected to appropriate thermal treatments to obtain an end product that is ready for consumption.

The shredded product, when mingled with real meat pieces (eg fish pieces) and gravy, has an appearance very similar to shredded meat chunks (eg fish chunks).

The shredded TPP can contain precursor materials which impart to the finished product a colour and taste very similar to that of the desired meat product which is mimicked by the analogue product (e.g. tuna, salmon, chicken, beef or lamb). However, the formulation of precursor materials can be varied as indicated above within a narrow range, and in particular flavouring agents in the form of additional meats and fats can be incorporated. These meats and fats may include *fish meat, fish oil,* chicken meat, chicken fat, beef, lamb or fats obtained from such meats. Thereby it is possible to obtain a shredded product that resembles and tastes like shredded fish meat, shredded chicken meat etc.

Example 2

A specific example of a meat analogue product manufactured in accordance with the invention and the process parameters used during its manufacture are provided below.

Meat analogue chunk having a fibrous striated structural matrix and resembling tuna white meat was prepared using the method and apparatus generally described above as follows:

The ingredients listed in Table 4 were weighed out as indicated there, milled through a hammer mill fitted with a screen of size 1.2 - 2 mm and pre-blended in a ribbon blender for 4 minutes.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method of manufacturing a texturised proteinaceous meat analogue product, including:

- subjecting, in a food extruder, a mixture containing:
  - about 40 to 95% by weight edible proteinaceous materials selected from the group consisting of predetermined mixtures of defatted soy flour, soy meal, soy concentrate, cereal gluten in vital or starch-containing form and egg white, and
  - up to about 7% by weight of edible mineral binding and cross-linking compounds;

  to mechanical pressure and added heat sufficient to convert the mixture into a hot, viscous protein lava;
- extruding the protein lava through and from a temperature controlled cooling die which cools and reduces the viscosity of the protein lava to obtain a cohesive, texturised, extrudate slab or ribbon in which vapour-flashing is substantially inhibited; and
- subjecting the solidified extrudate slab or ribbon to mechanical shredding in a hammer mill having a cage plate with a plurality of elongate discharge openings and a plurality of hammer bars hinged to discs attached to a rotating shaft, so as to obtain a plurality of extrudate shreds that resemble in consistency and texture flaked or shredded meat.

2. A method in accordance with claim 1, wherein meat or a meat by-product is added to the mixture.

3. A method in accordance with claim 2, wherein the meat or meat by-product is added during the extrusion step.

4. A method in accordance with any one of claims 1 to 3, wherein the extrudate slab or ribbon is transferred directly after leaving the cooling die to the hammer mill for shredding.

5. A method in accordance with any one of claims 1 to 4, wherein the mixture which is subjected to mechanical pressure and heat in the food extruder has a total moisture content of about 40 to 60%.

6. A method in accordance with claim 5, wherein water in an appropriate amount is added to the mixture itself, or into the extruder at a point downstream of the feeding entry for dry material mixture, so as to obtain a total moisture content of the extrudate slab or ribbon within a range of about 40 to 60%.

7. A method in accordance with any one of claims 1 to 6, wherein water is sprayed onto the extrudate slab or ribbon after exiting the cooling die and whilst being conveyed towards the hammer mill, so as to obtain a total moisture content of the extrudate slab or ribbon within a range of about 40 to 60%.

8. A method in accordance with any one of claims 1 to 7, wherein the mixture contains 75 to 95% by weight edible proteinaceous materials.

9. A method in accordance with any one of claims 1 to 6, wherein the mixture consists, in percent (%) by weight of mixture materials, of:

about 40 - 55% defatted soy flour, soy meal or soy concentrate;

about 35 - 45% vital wheat gluten, egg white powder, a mixture of vital wheat gluten and maize gluten or a mixture of vital wheat gluten and wheat flour;

0.1 - 7.0% of non-leaching mineral compounds including such that bind the protein matrix and enhance protein cross-linking;

optionally, 0 - 5% nutritional fibre additives, in particular cellulose or beet pulp;

0.1 - 0.3% vitamins;

0 - 3.0% flavouring agents; and

0.01 - 3.0% colouring agents.

10. A method in accordance with any one of claims 1 to 9, wherein the mixture consists, in percent (%) by weight of mixture materials, of about 51.5% defatted soy flour, about 42% vital wheat gluten, about 5% dicalcium phosphate, about 0.1% sulphur, about 0.18% nutritional vitamin supplements, about 0.2% nutritional mineral supplements, about 1.0% flavouring agents and about 0.002% colouring agents.

11. A method in accordance with any one of claims 1 to 8, wherein the mixture consists, in percent by weight, of about 41.6% soy concentrate, 42% vital wheat

gluten, 10% fibre, 5% di-calcium phosphate, 0.6% colouring agents, 0.5% salt, 0.2% vitamins and 0.1% sulphur.

12. A method in accordance with any one of claims 1 to 11, wherein the extrudate shreds, subsequent to the shredding operation, undergo further processing selected from the group consisting of freezing, dehydration and/or co-mingling with food products for subsequent packaging.

13. A production line for the manufacture of texturised proteinaceous meat analogue products, according to the method of any one of class 1 to 12, including:

a food extruder with a plurality of temperature-controlled barrel sections at least one feed opening adapted for receiving the mixture of claim 1 and a discharge opening arranged for discharging a hot, viscous protein lava;

a temperature-controlled cooling die located at the discharge opening and arranged for receiving the hot protein lava and cooling the same to such an extent that an at least surface-solidified, proteinaceous extrudate slab or ribbon exits the cooling die substantially without vapour flashing taking place in the extrudate;

a hammer mill having a cage plate with a plurality of elongate discharge openings and a plurality of hammer bars hinged to discs attached to a rotating shaft; and

conveyor means arranged to receive and convey the extrudate slab or ribbon from the cooling die to a feeding chute of the hammer mill.

14. A production line according to claim 13, wherein the cage plate openings of the hammer mill are of substantially uniform rectangular shape and area.

15. A production line according to claim 13 or claim 14, wherein the cage plate is bent into a semi-circular shape, and wherein the rectangular or oblong openings extend with their longer sides in circumferential extension of the plate.

16. A production line according to any one of claims 13 to 15, wherein the distance between openings, both laterally and longitudinally, is not more than 6 mm.

17. A production line according to any one of claims 11 to 14, wherein the cage